in this landscape where wind speeds are high may be cooler than those in other areas and have made it easier for the House Crows to adapt to these novel sites.

To fully assess the long-term costs and benefits to House Crows of locating their nests on pylons, further research on the nesting chronology (clutch size, incubation and breeding success) is needed as well as on the risks of collision with wires and electrocution on poles.

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New waterbird count data from the Heihe river in Gansu province, western China

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Introduction

The Heihe is China's second longest inland-draining river and lies within the Central Asian and East Asian–Australasian flyways for migratory waterbirds (Boere & Stroud 2006). No information on the Heihe is listed in the *Asian Waterbird Census 1987–2007* (Li *et al.* 2009), *Atlas of key sites for Anatidae in the East Asian flyway* (Miyabayashi & Mundkur 1999) or the *Asian-Australasian flyway site network* (DSEWPC 2009), and the river appears to be almost unknown in the international waterbird literature. Recent baseline species inventories (Chen *et al.* 2009, Zhangye City Government 2010) and a study of waterbird densities (Bao *et al.* 2012) established that the middle reaches of the river provide important habitat for waterbirds migrating across the arid regions of central-west China. Part of the river is designated an Important Bird Area, partly based on a report of 'more than 20,000 waterbirds' (BirdLife International 2009). In the early 1990s a small waterbird reserve was designated along the middle Heihe, and in 2010 this was expanded and upgraded to the Gansu Zhangye Heihe Wetland National Nature Reserve (NNR) (Zhangye City Government 2010) (Figure 1). In 2011 wetlands in and near the Gansu Zhangye Heihe Wetland NNR were visited by MRB and waterbirds observed. New waterbird count data for the Heihe are presented and the international importance of the Heihe for waterbird conservation is discussed.

Study area and methods

From its headwaters in the Qilian mountains of Gansu and Qinghai provinces, the Heihe flows north across a vast, arid plain, the Hexi corridor in Gansu province (the middle Heihe *c.*330 km), then drains

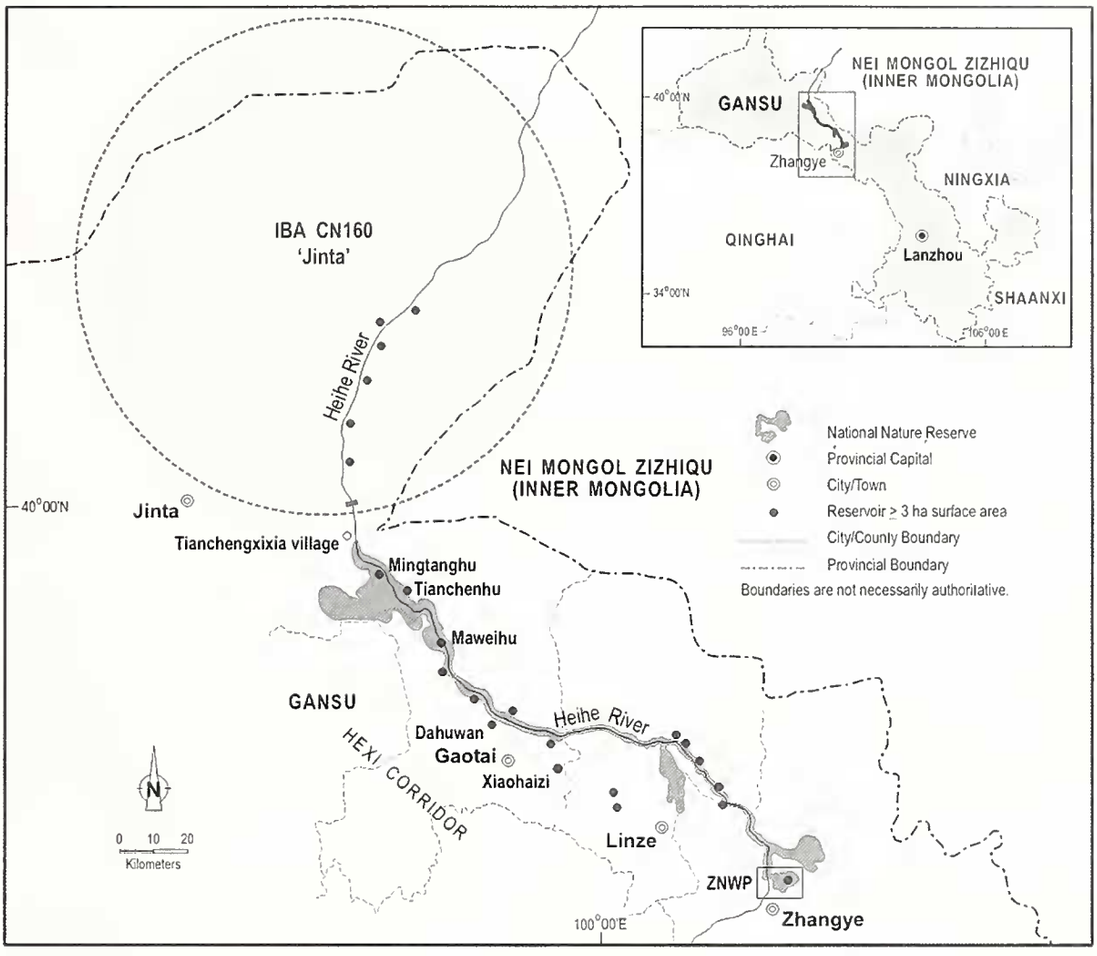

Figure 1. Localities mentioned in the text, including Important Bird Area CN160 Jinta (from BirdLife International 2009).

into Inner Mongolia province (the lower Heihe) (Figure 1). Waterbirds were counted at nine sites (elevations 1,278–1,460 m) in the middle Heihe: the Zhangye National Wetland Park (ZNWP), seven reservoirs and short sections of the Heihe between the ZNWP and the village of Tienchengxixia (Table 1, Figure 1). Six of these sites were within the Zhangye Heihe Wetland NNR (38.965°–39.875°N 99.323°–100.580°E; 41,164 ha) (hereafter 'the reserve'), which spans 160 km of the Heihe (Zhangye City Government 2010) (Figure 1). The reserve is characterised by low annual precipitation (mean 50–200 mm), high annual evaporation (mean 1,200–2,200 mm), extreme annual temperatures (–31°C, January to 41°C, July) and sandstorms (Zhangye City Government 2010).

The middle Heihe is a shallow, braided channel with rocky and alluvial substrates, gravel bars, marshes and sparse woodlands, bordered by a flat dry plain, and in the north-west, sand dunes and rocky gorges. Because of the regional scarcity of water, numerous reservoirs and irrigation networks have been constructed along the channel. Most riparian land is cultivated. The seven reservoirs surveyed were embanked structures with shallow and deep water, exposed mud, reeds *Phragmites*, reedmace *Typha* and/or stands of low shrubs or trees. The total surface area of the seven reservoirs was 1,505 ha. See Table 1 for details of elevation, surface area, length and width of all of the reservoirs, together with the distance from the Heihe. The 4,602 ha ZNWP (Zhangye City Government 2009) supports reed beds, woodland and farmland. Over one million people reside along the middle Heihe (Zhangye City Government 2010). Sites were initially identified from reserve maps. Reservoir dimensions and altitude were obtained from Google Earth satellite imagery, and field locations were recorded with a GPS. In total, 62.5 hours of field observations were made (Table 1). All sites were visited in early winter (October–November) and ZNWP was additionally visited in summer (July). Sites were traversed on foot.

Table 1. Sites visited in and near* the Gansu Zhangye Heihe Wetland National Nature Reserve, China, in 2011.

Name	Coordinates	Elevation (m)	Area (ha)	Length (km)	Width (km)	Distance to Heihe (km)	Dates[1]
ZNWP	38.974°N 100.455°E	1,460	n/a	n/a	n/a	0	17,19 Jul, 16,23–25, 28–29 Oct
Maweihu reservoir–east	39.586°N 99.635°E	1,313	163	2.35	0.8	0.57	1,6 Nov
Maweihu reservoir–west	39.596°N 99.621°E	1,313	240	1.68	1.42	0.57	1,6 Nov
Tianchenhu reservoir	39.709°N 99.567°E	1,300	202	3.81	0.77	0.05	1,6 Nov
Mingtanghu reservoir	39.745°N 99.503°E	1,292	220	2.81	1.27	0.3	1,6 Nov
Tienchengxixia village	39.823°N 99.436°E	1,278	n/a	n/a	n/a	0	1 Nov
Dahuwan reservoir–south*	39.401°N 99.744°E	1,340	191	2.28	1.23	0.78	31 Oct, 5 Nov
Dahuwan reservoir–north*	39.411°N 99.764°E	1,340	53	1.23	0.56	0.03	31 Oct, 5 Nov
Xiaohaizi reservoir*	39.290°N 99.889°E	1,370	436	4.86	2.27	5.72	7 Nov

[1]Survey effort: ZNWP: Jul = 10 hrs (05h00–10h45), Oct = 26.5 hrs (06h00–19h00), Dahuwan = 5.75 hrs (13h30–18h30), 'Gaotai' (Maweihu, Tianchenhu, Mingtanghu, Hei He, roadsides) = 16.5 hrs (08h30–17h00), Xiaohaizi = 3.75 hrs (08h40–12h25).

Waterbirds were counted using 10×42 binoculars and large flocks were counted at least twice to reduce count error. Because birds moving between sites may be double-counted, counts were pooled into four areas: Dahuwan (two reservoirs), Gaotai (Maweihu and Tianchenhu reservoirs, the Heihe, roadside wetlands), Xiaohaizi (three reservoirs) and ZNWP. For each area, a count estimate for each species was obtained by selecting the highest daily count recorded during visits to that area (Table 1). Counts for the four areas were summed to produce a total count. The risk of double-counting was considered low because: (i) 80% of the total count was made within a short time (three consecutive days, 5–7 November) and (ii) 26% of the total count comprised two flocks (see Results). Site visits only covered a small proportion of the middle Heihe, and 17 other large reservoirs along the channel, each with a surface area of 3 ha or more (Figure 1), were not visited. Counts for each species were compared against the 1% non-breeding population thresholds for East Asia given by Wetlands International (2012), to assess their conservation importance against criteria of the Ramsar Convention on Wetlands (Ramsar Convention Bureau 2008), to which China is a signatory.

Bird names, sequence and taxonomy follow Inskipp *et al.* (1996). IUCN Red List categories (Vulnerable, Near Threatened etc.) follow BirdLife International (2012).

Results

Forty waterbird species were observed in and near the reserve (Appendix 1); none was a new record for the middle Heihe. Compilation of available records yields an inventory of 71 waterbird species for the middle Heihe (Appendix 1); one species was excluded from this list, Black-necked Crane *Grus nigricollis*, mentioned by Ma & Ma (2001) but with no other details. These records include seven species of particular conservation concern: one Critically Endangered (Baer's Pochard *Aythya baeri*), three Vulnerable (Great Bustard *Otis tarda*, Relict Gull *Larus relictus*, Pallas's Fish Eagle *Haliaeetus leucoryphus*) and three Near Threatened (Ferruginous Pochard *A. nyroca*, Black-tailed Godwit *Limosa limosa*, Eurasian Curlew *Numenius arquata*). The bustard and eagle are not included as waterbirds for this study but are mentioned here for completeness. BirdLife International (2009) noted the Great Bustard bred along the middle Heihe in the 1950–1960s but has been 'extinct since the 1970s'; on 22 September 2008, two individuals were observed in the desert near Tianchenhu reservoir (Bao Xin-Kang *in litt.* 2012).

At least 8,504 individuals of 32 species were counted in early winter 2011, of which 7,023 (83%) were ducks, swans and geese of 15 species (Appendix 1). Mallard *Anas platyrhynchos* (2,804), Greylag Goose *Anser anser* (1,260) and Ruddy Shelduck *Tadorna ferruginea* (1,040) comprised 60% (5,104) of the count. Of the four survey areas visited in early winter, the highest count (all species combined) was in Gaotai (3,219) and the lowest was in ZNWP (325) (Appendix 1). Counts for three species exceeded the 1% non-breeding population estimates for East Asia: Greylag Goose (1,260 versus the 1% threshold of 710), Ruddy Shelduck (1,040 versus 710) and Black Stork *Ciconia nigra* (54 versus 1). Unpublished 2008 count data for Gaotai and Xiaohaizi (Bao Xin-Kang *in litt.* 2012) exceed the 1% thresholds for three species, Greylag Goose (810), Red-crested Pochard *Netta rufina* (4,214 versus 1,000 for South Asia) and Black Stork (81), and approach that for Whooper Swan *Cygnus cygnus* (420 versus 600). For Red-crested Pochard, which is mainly a species of the Central-South Asian flyway rather than the East Asian flyway (Miyabayashi & Mundkur 1999), no 1% threshold is available for East Asia (Wetlands International 2012). Comparison with the South Asia 1% threshold is appropriate and is given above.

Discussion

This appears to be the first assessment of the importance of the Heihe river for waterbirds against international conservation criteria. Comparison of count data with criteria of the Ramsar Convention Bureau (2008) indicates the middle Heihe satisfies at least one, and possibly two, criteria signifying a Wetland of International Importance. For at least four species, Greylag Goose, Ruddy Shelduck, Red-crested Pochard and Black Stork, the middle Heihe appears to meet criterion 6 (a wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird). The total early winter count in 2011 (8,504 individuals) suggests that criterion 5 (a wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds) may also be met. Given the limited sampling effort and coverage of the current observations, the low risk of double-counting and that counts of large flocks tend to underestimate total numbers (Rappoldt *et al.* 1985), it seems reasonable to conclude that the middle Heihe supports more than 20,000 waterbirds in the non-breeding season. Waterbird surveys in China have largely focused on coastal wetlands in the east (e.g. Barter *et al.* 2005, Cao *et al.* 2008), as have recent national censuses (Li *et al.* 2009, China Coastal Waterbird Census Team 2010). Cao *et al.* (2008) speculated that few waterfowl occur west of 110°E in the non-breeding season, because of limited habitat and cold winters. The current findings confirm that the Heihe, which extends from c.90.333 to 100.433°E (i.e. c.830 km west of 110°E) supports internationally important waterbird populations. Insufficient data are available to assess the current local status of the seven globally threatened and Near Threatened species recorded in the reserve.

Reservoirs along the middle Heihe provide important habitat for migratory waterbirds. At least 2,691 individuals (32%) counted in early winter 2011 were recorded in fewer than four hours within a single reservoir complex, Xiaohaizi, and many waterbirds were observed at other reservoirs (Appendix 1). This is notable compared with reservoirs in eastern China, which generally support few waterfowl (Cao *et al.* 2008), and recreational lakes, which often support large numbers of people, few wetland habitats, and low bird species richness (Zhao *et al.* 2008, Niu *et al.* 2011, MRB pers. obs.).

The timing of peak waterbird migration in the middle Heihe is unknown. Raw count data for Gaotai was 33% higher on 6 November (2,757) than on 1 November (1,834), and this increase could not be accounted for by numbers recorded on previous days in other areas, suggesting that migrants were continuing to arrive. Counts for Greylag Goose, Ruddy Shelduck and Mallard were higher in October–November than recorded by Bao Xin-Kang (*in litt.* 2012) in September (Appendix 1). In contrast, counts in September for Red-crested Pochard and in December for Whooper Swan, both by Bao Xin-Kang (*in litt.* 2012), were over seven and ten times higher respectively than counts in October–November 2011 in the same survey areas. No count data for the middle Heihe are available from January–February, possibly because most waterbodies are frozen at that time and few waterbirds may be present. Important Bird Area CN160 Jinta (BirdLife International 2009) encompasses the Heihe downstream of the reserve (Figure 1). The current findings suggest the IBA boundaries should be extended to the east to encompass the reserve.

Loss and degradation of wetlands are the key threats to waterbirds in the middle Heihe. Intensive industrial and agricultural development has resulted in declining water tables, vegetation dieback, pollution and salinisation (Qi & Luo 2006). Conservation priorities for waterbirds include habitat restoration (Chen *et al.* 2009) and a comprehensive survey of the middle and lower Heihe to determine seasonal waterbird numbers and identify key conservation sites.

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Appendix 1

Waterbird records and available count data from within and near the Gansu Zhangye Heihe Wetland National Nature Reserve, China.

Species	Chen *et al.* (2009)	ZCG (2010)	Bao *et al.* (2012)*	This study Summer (July) ZNWP	This study Early winter (October–November) ZWNP	Gaotai	Dahuwan	Xiaohaizi	Total no. early winter
Mute Swan *Cygnus alar*	x								
Whooper Swan *Cygnus cygnus*	x	x	x (Ma-420)			30		9	39
Tundra Swan *Cygnus columbianus*	x	x[1]	x						
Bean Goose *Anser fabalis*		x	x (Ma-80)			1		50	51
Greylag Goose *Anser anser*	x	x	x (Xi-810)			60		1,200	1,260
Bar-headed Goose *Anser indicus*		x	x						
Ruddy Shelduck *Tadarna ferruginea*	x	x	x (Ma-428)		11	1,017	12		1,040
Common Shelduck *Tadarna tadarna*	x	x	x			15			15
Gadwall *Anas strepera*		x	x (Ma-102)		9	50	220		279
Eurasian Wigeon *Anas penelape*		x	x						
Mallard *Anas platyrhynchas*	x	x	x (Mi-780)		70	1,081	813	840	2,804

Species	Chen *et al.* (2009)	ZCG (2010)	Bao *et al.* (2012)*	This study Summer (July) ZNWP	This study Early winter (October–November) ZWNP	Gaotai	Dahuwan	Xiaohaizi	Total no. early winter
Spot-billed Duck *Anos poecilorhyncho*		x	x (Ma-54)	33	65	7	39	30	141
Northern Shoveler *Anos clypeoto*	x	x	x						
Northern Pintail *Anos ocuto*		x	x						
Common Teal *Anos crecco*	x	x	x (Ma-320)		41	50+	300		391
Red-crested Pochard *Netto rufino*		x	x (Ma-4214)		2	575		10	587
Common Pochard *Aythyo ferino*		x	x (Ma-60)		1				1
Ferruginous Pochard *Aythyo nyroco*	x	x	x (Ma-59)	5	35	60	20	105	220
Baer's Pochard *Aythyo boeri*		x	x (Ma-12)						
Tufted Duck *Aythyo fuligulo*	x	x	x (Xi-22)		1	20	2		23
Common Goldeneye *Bucepholo clongulo*		x	x (Ma-67)			30	22	90	142
Red-breasted Merganser *Mergus serrotor*	x								
Common Merganser *Mergus merganser*	x							30	30
Demoiselle Crane *Grus virgo*	x[2]								
Common Crane *Grus grus*	x	x							
Water Rail *Rallus aquaticus*		x	x	2					0
Baillon's Crake *Porzana pusillo*		x							
Common Moorhen *Gallinulo chloropus*		x	x (Mi-5)	5					0
Common Coot *Fulico otro*		x	x (Mi-1190)	28	45		200	272	517
Eurasian Woodcock *Scolopax rusticolo*		x	x						
Common Snipe *Gallinago gallinago*	x	x	x		[10]		[3]		13
Black-tailed Godwit *Limosa limosa*	x	x	x (Da-73)				2		2
Eurasian Curlew *Numenius arquato*		x	x (Xw-2)						
Spotted Redshank *Tringa erythropus*	x	x							
Common Redshank *Tringa totanus*	x	x	x			6	1		7
Marsh Sandpiper *Tringa stagnatilis*		x	x						
Common Greenshank *Tringa nebularia*		x	x				10	1	11
Green Sandpiper *Tringa ochropus*	x	x	x		2		3		5
Wood Sandpiper *Tringa glareola*	x								
Common Sandpiper *Actitis hypoleucos*	x	x	x	1					0
Red-necked Stint *Calidris ruficollis*	x	x							
Temminck's Stint *Calidris temminckii*	x	x	x						
Long-toed Stint *Calidris subminuta*	x								
Dunlin *Calidris alpina*		x	x						
Curlew Sandpiper *Calidris ferruginea*	x	x	x						
Black-winged Stilt *Himantopus himantopus*	x	x	x	5					0
Pied Avocet *Recurvirostra avosetta*		x	x						
Pacific Golden Plover *Pluvialis fulva*	x[3]	x[3]	x						
Little Ringed Plover *Charadrius dubius*	x	x	x						
Kentish Plover *Charadrius alexandrinus*	x	x	x						
Northern Lapwing *Vanellus vanellus*	x	x	x		10	21	16		47
Grey-headed Lapwing *Vanellus cinereus*		x	x						
Pallas's Gull *Larus ichthyaetus*	x	x	x		1	10	23	12	46
Brown-headed Gull *Larus brunnicephalus*	x	x	x						
Black-headed Gull *Larus ridibundus*	x	x				10	111	7	128
Relict Gull *Larus relictus*	x	x							

Species	Chen *et al.* (2009)	ZCG (2010)	Bao *et al.* (2012)*	This study Summer (July) ZNWP	This study Early winter (October–November) ZWNP	Gaotai	Dahuwan	Xiaohaizi	Total no. early winter
Common Tern *Sterna hirunda*	x	x	x	200					0
Little Tern *Sterna albifrans*		x							
Whiskered Tern *Chlidanias hybridus*		x	x	2					0
Little Grebe *Tachybaptus ruficallis*	x	x	x	16	6	8	20	2	36
Great Crested Grebe *Podiceps cristatus*	x	x	x	6	1	3	12	3	19
Great Cormorant *Phalacracarax carba*	x	x	x (Xi-60)		1	7	200	5	213
Grey Heron *Ardea cinerea*	x	x	x	1	3	12	18	1	34
Great Egret *Casmeradius albus*	x	x	x		9	93	168	24	294
Chinese Pond Heron *Ardeala bacchus*	x	x	x	1	2		2		4
Black-crowned Night Heron *Nycticarax nycticarax*		x	x	11					0
Yellow Bittern *Ixabrychus sinensis*	x	x	x	6					0
Black Bittern *Dupetar flavicallis*		x							
Great Bittern *Bataurus stellaris*	x								
Eurasian Spoonbill *Platalea leucaradia*		x	x (Xy-16)				51		51
Black Stork *Cicania nigra*	x	x	x (Xy-81)			53	1		54
Total				322	325	3,219	2,269	2,691	**8,504**

[1]Listed as '*C. bewickii*', [2]as '*Anthrapaides virga*', and [3]as '*P. dominica*'. [ ] = provisionally identified. *Species records are from Bao *et al.* (2012) and count data is from Bao Xin-Kang (*in litt.* 2012): their counts were made over 24–27 September 2008 except for Whooper Swan (12 December 2008) and Black-tailed Godwit (6 August 2008). Their survey sites were: 'Da' (Dahuwan), 'Ma' (Maweihu reservoir), 'Mi' (Mingtanghu reservoir), 'Ti' (desert near Tianchenhu reservoir), 'Xi' (Xiaohaizi), 'Xw' (Xiwan), 'Xy' (Xiyaodun); all sites are within the 'Gaotai' area of the current study.

Breeding biology of the Small Snowfinch *Pyrgilauda davidiana* on the Tibetan plateau

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Introduction

The snowfinch complex, *Montifringilla, Onychostruthus* and *Pyrgilauda*, comprising eight species, has its central distribution on the Tibetan plateau (Qu *et al.* 2006, Summers-Smith 2009). Occurring from 2,000 to 5,500 m, snowfinches have the highest distributional elevation of all the passerines (Qu *et al.* 2002). They are well adapted to the open alpine meadow and rocky habitats of the Tibetan plateau. Adaptive radiation of snowfinches is thought to have occurred 2 million years ago with dramatic climatic changes caused by the uplift of the Tibetan plateau (Qu *et al.* 2006). However, data on the basic natural history of these species are sparse, although breeding of White-winged Snowfinches *Montifringilla nivalis*, White-rumped Snowfinches *Onychostruthus taczanowskii* and Rufous-necked Snowfinches *Pyrgilauda ruficollis* has been briefly described (Cramp & Perrins 1994, Zeng & Lu 2009a,b).

The Small Snowfinch *P. davidiana* weighing about 20 g, is one of the smallest snowfinches (Clement *et al.* 1993), distinguished from other snowfinch species by a black face mask continuous with a prominent black patch on the throat. It is found in the Russian Altai, Transbaikalia, Mongolia and north China, inhabiting meadow and semi-desert areas, mostly between 1,000 and 3,500 m. Little is known about the reproduction of this species. Here, we report the breeding biology of the Small Snowfinch at an altitude of 3,400 m on the north-east Tibetan plateau.

Study site and field procedure

This work was conducted during 2010–2011 in Tianjun county, north-east Tibetan plateau (37.283°N 99.017°E) at 3,400 m. The annual mean temperature in this area is –1.1°C and the total precipitation 345 mm (data from the weather records of a local weather station from 1990 to 2010). This site is an open, flat meadow landscape. More information on vegetation and other aspects is available in Wang *et al.* (2007) and Li & Lu (2012a).

We searched for snowfinch nests within a 180 ha study plot by following adults' breeding activities. The nests were located in abandoned burrows of Black-lipped Pikas *Ochotona curziona*. When a nest was discovered, we mapped the location with a GPS and recorded the direction of the burrow entrance. Adults were caught by mist-net at the burrow entrance during the nestling period, and ringed with colour rings and a numbered metal ring. We measured their body weight and the length of body, wing, tarsus and bill using an electronic balance and calipers. The sexes are similar, and adults were sexed by social behaviour, a female-specific incubation patch and the throat-patch (bigger and darker in males than females).

For some nests, we dug vertical inspection holes where the tunnel changed direction to find the nest. The inspection hole close to the nest was packed with soil-filled bags to facilitate subsequent inspections, and other holes were covered with original greensward to reduce the risk of predation. Egg size, clutch size, incubation period, nestling period and fledging success were estimated through checking nest contents. Hatchlings were marked by clipping specific tufts before they were eight days old; later they were ringed following the same procedure as for adults. Young from selected nests were weighed every three days. Nests were visited at least once a week to check nestling development and the current condition of the nest. When dates of egg laying, hatching or fledging were approaching, we increased nest visits to record these events as they occurred. Nest dimensions were measured after the young fledged. Nesting